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(54) **CATALYST FOR SYNERGISTIC CONTROL OF OXYNITRIDE AND MERCURY AND METHOD FOR PREPARING THE SAME**

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(57) **ABSTRACT**

Disclosed are a catalyst for synergistic control of oxynitride and mercury and a method for preparing the same. The catalyst includes the following components by mass percentage: a carrier: TiO₂ 72%-98.6%, active components: V₂O₅ 0.1%-5%, WO₃ 1%-10%, Cr₂O₃ 0.1%-5% and Nb₂O₅ 0.1%-5%, and a co-catalyst of 0.1%-3%. The present invention can be used for reducing the oxynitrides in a flue gas, meanwhile oxidizing zero-valent mercury into bivalent mercury and then controlling the reactions, has relatively high denitration performance and also has high mercury oxidation performance; compared with current commercial SCR catalysts, the mercury oxidation rate of the catalyst is improved to a great extent, which can adapt to the requirements for mercury removal in China's coal-fired power plants, the conversion rate of SO₂/SO₃ is relatively low, and the catalyst has a better anti-poisoning ability, and is a new catalyst with a low cost and high performance.

5 Claims, No Drawings

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CATALYST FOR SYNERGISTIC CONTROL OF OXYNITRIDE AND MERCURY AND METHOD FOR PREPARING THE SAME

This is a U.S. national stage application of PCT Appli-
cation No. PCT/CN2013/089075 under 35 U.S.C. 371, filed
Dec. 11, 2013 in Chinese, which is hereby incorporated by
reference.

FIELD OF THE INVENTION

The present invention relates to a catalyst production
technology field, especially a catalyst for synergistic control
of oxynitride and mercury and a method for preparing the
same.

BACKGROUND OF THE INVENTION

Mercury, as a kind of toxic heavy metal, may injure
nervous system, brain tissue and liver tissue after entering
into the human body, and can accumulate in living creature
and transfer around the world along with the food chain, thus
having great harms. About one third of mercury discharged
into the atmosphere comes from the mixed combustion
process of coal or coal and wastes and the environmental
protection pressure in China is tremendous because of the
huge consumption of coal.

Considering that most power plants are now equipped
with selective catalytic reduction (SCR) denitration devices
and wet desulfurization systems, there is no need to add
independent mercury removal equipment by oxidizing zero-
valent mercury into bivalent mercury and then removing
mercury in desulfurization system, which will help power
plants to save pollutant control cost and have greater appli-
cation prospect. However, low-chlorine coal is mainly used
in power plants in China with lower HCl concentration in
flue gas, while the current commercial SCR catalyst has a
low mercury oxidation efficiency, which restricts the control
of mercury in coal-fired power plants especially under the
condition of low chlorine.

A Chinese patent CN102764655A discloses a new mer-
cury removal catalyst which is prepared via pillared mont-
morillonite by mixing TO_x (T refers to Cu, Fe, V) and RO_y
(R refers to La, Ce) with titanium dioxide. Such catalyst has
high mercury removal efficiency, a certain anti-poisoning
ability, no denitration capability and a complicated prepara-
tion process, and thus is not applicable for industrial
application.

SUMMARY OF THE INVENTION

The present invention aims at solving such problems as
low zero-valent mercury oxidation efficiency, narrow tem-
perature window, poor anti-poisoning ability and other
shortages of the current commercial SCR catalyst, and
providing a catalyst for synergistic control of oxynitride and
mercury to reduce the oxynitrides in a flue gas, meanwhile
oxidize zero-valent mercury into bivalent mercury and then
control the reactions, so as to have relatively high denitration
performance and also has high mercury oxidation perfor-
mance. Compared with prior art commercial SCR catalysts,
the mercury oxidation rate of the catalyst of the present
invention improved greatly, which can satisfy the require-
ments for mercury removal in China's coal-fired power
plants, the conversion rate of SO_2/SO_3 is relatively low, and
the catalyst has a better anti-poisoning ability, and is a new
catalyst with a low cost and high performance.

The present invention also discloses a method for prepar-
ing the catalyst which is simple, practicable and applicable
for industrial production.

Technical solution for solving problem in the present
invention is as follows:

A catalyst for synergistic control of oxynitride and mercury
and the catalyst comprises the following components by
mass percentage: a carrier: TiO_2 72-98.6%,
active components: V_2O_5 0.1-5%, WO_3 1-10%, Cr_2O_3 0.1-
5% and Nb_2O_5 0.1-5%,
and a co-catalyst of 0.1-3%.

It is preferred that the co-catalyst is selected from CuO ,
 Fe_2O_3 and MoO_3 .

It is preferred that the TiO_2 is nanoscale anatase TiO_2 with
particle size of less than 30 nm and the preferred particle
size is less than 20 nm.

A method for preparing the catalyst for synergistic control of
oxynitride and mercury, comprising the step of:

1) drying TiO_2 and using it as a carrier;
2) stirring ammonium metavanadate and ammonium
metatungstate under $50^\circ C$ - $70^\circ C$. to dissolve them in an
oxalic acid or tartaric acid solution to obtain a solution A
with pH value less than 2;

stirring chromic nitrate under 10 - $50^\circ C$. to dissolve in
deionized water or tartaric acid to obtain a solution B;
stirring niobium oxalate under 50 - $70^\circ C$. to dissolve in
deionized water or tartaric acid to obtain a solution C;

3) stirring cupric nitrate under 10 - $50^\circ C$. to dissolve in
deionized water or tartaric acid to obtain a solution D;
or stirring ferric nitrate under 10 - $50^\circ C$. to dissolve in
deionized water or tartaric acid to obtain a solution E;
or stirring ammonium molybdate under 10 - $50^\circ C$. to
dissolve in deionized water or tartaric acid to obtain a
solution F;

4) mixing the solution A, solution B and solution C with
one of the solution D, solution E and solution F to obtain an
impregnating solution, immersing the carrier from step 1)
into the impregnating solution, stirring evenly for ultrasound
concussion, evaporating and stirring with water bath for
10-60 minutes, drying in the oven and then calcining under
 $400^\circ C$ - $550^\circ C$. for 3-5 h to obtain a catalyst for synergistic
control of oxynitride and mercury.

Concentration of oxalic acid and tartaric acid in the
present invention is preferred to be 1 -10wt % and 1 -20wt
% respectively.

It is preferred that the drying in step 1) is drying under $105^\circ C$ - $120^\circ C$. for 12 hours-24 hours.

It is preferred that the ultrasound concussion time in step 4)
is 10-60 minutes.

It is preferred that the water bath temperature in step 4) is
 70 - $90^\circ C$.

It is preferred that the drying condition in oven in step 4) is
drying under 105 - $120^\circ C$. for 12-24 hours.

During research, the inventor unexpectedly found that the
synergistic effect of Cr_2O_3 and Nb_2O_5 can accelerate mer-
cury oxidation to a much greater extent and improve deni-
tration activity with minor impact on SO_2/SO_3 conversion
rate. The addition of CuO , FeO or MoO_3 can improve the
stability and poison resistance and expand the reaction
temperature window of the catalyst.

Based on long-term engagement in flue gas denitration,
mercury removal and synergetic control of multiple pollut-
ants, the inventor developed a catalyst for synergistic control
of oxynitride and mercury so that the catalyst has higher
denitration performance and higher mercury oxidation per-
formance. Compared with current commercial SCR cata-
lysts, the mercury oxidation rate of the catalyst is improved

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to a great extent, which can adapt to the requirements for mercury removal in China's coal-fired power plants, the conversion rate of SO_2/SO_3 is relatively low, and the catalyst has a better anti-poisoning ability, and is a new catalyst with a low cost and high performance.

Beneficial effects of the present invention include:

1) accelerated denitration performance and mercury oxidation performance of catalyst and save pollutant control cost; 2) relatively high oxidation rate of zero-valent mercury under low-chlorine condition; 3) good anti-poisoning performance of catalyst and strong adaptability to severe operating conditions; 4) simple preparation process with lower cost; and thus the catalyst can be extensively applied in flue gas denitration and mercury removal in coal-fired power plants.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Technical solution to the present invention will be further described next with specific embodiments.

Unless otherwise particularly specified, raw materials and equipment used in the present invention can be purchased from the market or are commonly used in this field, and, unless otherwise particularly specified, methods in the following examples are conventional methods in this field.

EXAMPLE 1

1) TiO_2 (nanoscale anatase TiO_2 , commercially available, particle size less than 30 nm) was dried under 105°C . for 12 hours and used as a carrier;

2) Ammonium metavanadate and ammonium metatungstate were stirred under 50°C . to dissolve in oxalic acid solution to obtain a solution A with pH value less than 2; Chromic nitrate was stirred under 10°C . to dissolve in deionized water to obtain a solution B; Niobium oxalate was stirred under 50°C . to dissolve in deionized water to obtain a solution C;

3) Cupric nitrate was stirred under 10°C . to dissolve in deionized water to obtain a solution D;

4) The solution A, solution B and solution C were mixed with the solution D to obtain an impregnating solution, the carrier from step 1) was immersed into the impregnating solution, stirred evenly for ultrasound concussion with ultrasonic cleaner for 10 minutes, evaporated and stirred with water bath under 70°C . for 10 minutes, dried in the oven under 105°C . for 12 hours and then calcine under 400°C . for 5 hours to obtain a catalyst for synergistic denitration and mercury oxidation with V_2O_5 , WO_3 , Cr_2O_3 , Nb_2O_5 and CuO in the following mass percentage: carrier TiO_2 98.6%, active component V_2O_5 0.1%, active component WO_3 1%, active component Cr_2O_3 0.1%, active component Nb_2O_5 0.1% and co-catalyst CuO 0.1%. The prepared catalyst was grounded and sieved to obtain catalyst particles with particle size of 40-60 mesh.

Test 1:

0.2 g catalyst particle prepared in example 1 was put into a catalyst denitration activity evaluation unit and activity evaluation was conducted in a fixed bed reactor with inner diameter of 8 mm. O_2/N_2 , NO/N_2 , NH_3/N_2 , SO_2/N_2 and N_2 were controlled and mixed via mass flowmeter, deionized water was injected into heating pipeline for vaporization by adjusting volume in a micro-injection pump to realize addition of vapor and obtain simulated flue gas in such composition as 5% O_2 , 1000 ppmNO, 1000 NH_3 , 500 ppm SO_2 and 10% H_2O , with N_2 as balance gas, air speed of 300000 h^{-1} ,

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reaction temperature of 350°C . and NH_3/NO as 1. Test gas composition with ULTRMAT 32 gas analyzer manufactured by SIEMENS and the denitration efficiency was 72%.

0.2 g catalyst particle prepared in example 1 was put into a catalyst mercury removal activity evaluation unit and activity evaluation was conducted in a fixed bed reactor with inner diameter of 8 mm. Hg^0/N_2 , O_2/N_2 , HCl/N_2 , NO/N_2 , NH_3/N_2 , SO_2/N_2 and N_2 were controlled and mixed via mass flowmeter, deionized water was injected into heating pipeline for vaporization by adjusting volume in a micro-injection pump to realize addition of vapor and obtain simulated flue gas in such composition as 100 $\mu\text{g}/\text{m}^3\text{Hg}^0$, 5% O_2 , 10 ppmHCl, 300 ppmNO, 50 ppm NH_3 , 500 ppm SO_2 and 10% H_2O , with N_2 as balance gas, air speed of 300000 h^{-1} and reaction temperature of 350°C . Mercury concentration was tested with EMP-2 portable mercury analyzer manufactured by NIC and the oxygenation rate of zero-valent mercury was 68%.

EXAMPLE 2

1) TiO_2 (nanoscale anatase TiO_2 , commercially available, particle size less than 30 nm) was dried under 105°C . for 12 hours and used as a carrier;

2) Ammonium metavanadate and ammonium metatungstate were stirred under 50°C . to dissolve in tartaric acid solution to obtain a solution A with pH value less than 2;

Chromic nitrate was stirred under 10°C . to dissolve in deionized water to obtain a solution B;

Niobium oxalate was stirred under 50°C . to dissolve in deionized water to obtain a solution C;

3) Cupric nitrate was stirred under 30°C . to dissolve in tartaric acid to obtain a solution D;

4) the solution A, solution B and solution C were mixed with the solution D to obtain an impregnating solution, the carrier from step 1) was immersed into the impregnating solution, stirred evenly for ultrasound concussion with ultrasonic cleaner for 10 minutes, evaporated and stirred with water bath under 70°C . for 10 minutes, dried in the oven under 105°C . for 12 hours and then calcined under 400°C . for 5 hours to obtain a catalyst for synergistic denitration and mercury oxidation with V_2O_5 , WO_3 , Cr_2O_3 , Nb_2O_5 and CuO in the following mass percentage: carrier TiO_2 92.4%, active component V_2O_5 0.1%, active component WO_3 1%, active component Cr_2O_3 2.5%, active component Nb_2O_5 2.5% and co-catalyst CuO 1.5%. The prepared catalyst was grounded and sieved to obtain catalyst particles with particle size of 40-60 mesh.

Test 2:

0.2 g catalyst particle prepared in example 2 was put into a catalyst denitration activity evaluation unit and activity evaluation was conducted in a fixed bed reactor with inner diameter of 8 mm. O_2/N_2 , NO/N_2 , NH_3/N_2 , SO_2/N_2 and N_2 were controlled and mixed via mass flowmeter, deionized water was injected into heating pipeline for vaporization by adjusting volume in a micro-injection pump to realize addition of vapor and obtain simulated flue gas in such composition as 5% O_2 , 1000 ppmNO, 1000 NH_3 , 500 ppm SO_2 and 10% H_2O , with N_2 as balance gas, air speed of 300000 h^{-1} , reaction temperature of 350°C . and NH_3/NO as 1. Gas composition was tested with ULTRMAT 32 gas analyzer manufactured by SIEMENS and the denitration efficiency was 75%.

0.2 g catalyst particle prepared in example 2 was put into a catalyst mercury removal activity evaluation unit and activity evaluation was conducted in a fixed bed reactor with inner diameter of 8 mm. Hg^0/N_2 , O_2/N_2 , HCl/N_2 , NO/N_2 ,

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NH₃/N₂, SO₂/N₂ and N₂ were controlled and mixed via mass flowmeter, deionized water was injected into heating pipeline for vaporization by adjusting volume in a micro-injection pump to realize addition of vapor and obtain simulated flue gas in such composition as 100 μg/m³Hg⁰, 5%O₂, 10 ppmHCl, 300 ppmNO, 50 ppmNH₃, 500 ppmSO₂ and 10%H₂O, with N₂ as balance gas, air speed of 300000 h⁻¹ and reaction temperature of 350° C. Mercury concentration was tested with EMP-2 portable mercury analyzer manufactured by NIC and the oxygenation rate of zero-valent mercury was 70%.

EXAMPLE 3

1) TiO₂ (nanoscale anatase TiO₂, commercially available, particle size less than 30 nm) was dried under 105° C. for 12 hours and used as a carrier;

2) Ammonium metavanadate and ammonium metatungstate were stirred under 50° C. to dissolve in oxalic acid solution to obtain a solution A with pH value less than 2;

Chromic nitrate was stirred under 10° C. to dissolve in deionized water to obtain a solution B;

Niobium oxalate was stirred under 50° C. to dissolve in deionized water to obtain a solution C;

3) Cupric nitrate was stirred under 50° C. to dissolve in deionized water to obtain a solution D;

4) The solution A, solution B and solution C were mixed with the solution D to obtain an impregnating solution, the carrier from step 1) was immersed into the impregnating solution, stirred evenly for ultrasound concussion with ultrasonic cleaner for 10 minutes, evaporated and stirred with water bath under 70° C. for 10 minutes, dried in the oven under 105° C. for 12 hours and then calcined under 400° C. for 5 hours to obtain a catalyst for synergistic denitration and mercury oxidation with V₂O₅, WO₃, Cr₂O₃, Nb₂O₅ and CuO in the following mass percentage: carrier TiO₂ 85.9%, active component V₂O₅ 0.1%, active component WO₃ 1%, active component Cr₂O₃ 5%, active component Nb₂O₅ 5% and co-catalyst CuO 3%. The prepared catalyst was grounded and sieved to obtain catalyst particles with particle size of 40-60 mesh.

Test 3

0.2 g catalyst particle prepared in example 3 was put into a catalyst denitration activity evaluation unit and activity evaluation was conducted in a fixed bed reactor with inner diameter of 8 mm. O₂/N₂, NO/N₂, NH₃/N₂, SO₂/N₂ and N₂ were controlled and mixed via mass flowmeter, deionized water was injected into heating pipeline for vaporization by adjusting volume in a micro-injection pump to realize addition of vapor and obtain simulated flue gas in such composition as 5% O₂, 1000 ppmNO, 1000NH₃, 500 ppmSO₂ and 10% H₂O, with N₂ as balance gas, air speed of 300000 h⁻¹, reaction temperature of 350° C. and NH₃/NO as 1. Gas composition was tested with ULTRMAT 32 gas analyzer manufactured by SIEMENS and the denitration efficiency was 79%.

0.2 g catalyst particle prepared in example 3 was put into a catalyst mercury removal activity evaluation unit and activity evaluation was conducted in a fixed bed reactor with inner diameter of 8 mm. Hg⁰/N₂, O₂/N₂, HCl/N₂, NO/N₂, NH₃/N₂, SO₂/N₂ and N₂ were controlled and mixed via mass flowmeter, deionized water was injected into heating pipeline for vaporization by adjusting volume in a micro-injection pump to realize addition of vapor and obtain simulated flue gas in such composition as 100 μg/m³Hg⁰, 5% O₂, 10 ppmHCl, 300 ppmNO, 50 ppmNH₃, 500 ppmSO₂ and 10% H₂O, with N₂ as balance gas, air speed of 300000

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h⁻¹ and reaction temperature of 350° C. Mercury concentration was tested with EMP-2 portable mercury analyzer manufactured by NIC and the oxygenation rate of zero-valent mercury was 73%.

EXAMPLE 4

1) TiO₂ (nanoscale anatase TiO₂, commercially available, particle size less than 30 nm) was tried under 110° C. for 18 hours and used as a carrier;

2) Ammonium metavanadate and ammonium metatungstate were stirred under 60° C. to dissolve in oxalic acid solution to obtain a solution A with pH value less than 2;

Chromic nitrate was stirred under 30° C. to dissolve in deionized water to obtain a solution B;

Niobium oxalate was stirred under 60° C. to dissolve in deionized water to obtain a solution C;

3) Ferric nitrate was stirred under 10° C. to dissolve in deionized water to obtain a solution E;

4) The solution A, solution B and solution C were mixed with the solution E to obtain an impregnating solution, the carrier from step 1) was immersed into the impregnating solution, stirred evenly for ultrasound concussion with ultrasonic cleaner for 30 minutes, evaporated and stirred with water bath under 80° C. for 30 minutes, dried in the oven under 110° C. for 18 hours and then calcined under 475° C. for 4 hours to obtain a catalyst for synergistic denitration and mercury oxidation with V₂O₅, WO₃, Cr₂O₃, Nb₂O₅ and Fe₂O₃ in the following mass percentage:

carrier TiO₂ 92.2%, active component V₂O₅ 2.5%, active component WO₃ 5%, active component Cr₂O₃ 0.1%, active component Nb₂O₅ 0.1% and co-catalyst Fe₂O₃ 0.1%. The prepared catalyst was grounded and sieved to obtain catalyst particles with particle size of 40-60 mesh.

Test 4

0.2 g catalyst particle prepared in example 4 was put into a catalyst denitration activity evaluation unit and activity evaluation was conducted in a fixed bed reactor with inner diameter of 8 mm. O₂/N₂, NO/N₂, NH₃/N₂, SO₂/N₂ and N₂ were controlled and mixed via mass flowmeter, deionized water was injected into heating pipeline for vaporization by adjusting volume in a micro-injection pump to realize addition of vapor and obtain simulated flue gas in such composition as 5% O₂, 1000 ppmNO, 1000 NH₃, 500 ppmSO₂ and 10%H₂O, with N₂ as balance gas, air speed of 300000 h⁻¹, reaction temperature of 350° C. and NH₃/NO as 1. Gas composition was tested with ULTRMAT 32 gas analyzer manufactured by SIEMENS and the denitration efficiency was 83%.

0.2 g catalyst particle prepared in example 4 was put into a catalyst mercury removal activity evaluation unit and activity evaluation was conducted in a fixed bed reactor with inner diameter of 8 mm. Hg⁰/N₂, O₂/N₂, HCl/N₂, NO/N₂, NH₃/N₂, SO₂/N₂ and N₂ was controlled and mixed via mass flowmeter, deionized water was injected into heating pipeline for vaporization by adjusting volume in a micro-injection pump to realize addition of vapor and obtain simulated flue gas in such composition as 100 μg/m³Hg⁰, 5% O₂, 10 ppmHCl, 300 ppmNO, 50 ppmNH₃, 500 ppmSO₂ and 10% H₂O, with N₂ as balance gas, air speed of 300000 h⁻¹ and reaction temperature of 350° C. Mercury concentration was tested with EMP-2 portable mercury analyzer manufactured by NIC and the oxygenation rate of zero-valent mercury was 79%.

EXAMPLE 5

1) TiO₂ (nanoscale anatase TiO₂, commercially available, particle size less than 30 nm) was dried under 110° C. for 18 hours and used as a carrier;

2) Ammonium metavanadate and ammonium metatungstate were stirred under 60° C. to dissolve in tartaric acid solution to obtain a solution A with pH value less than 2;

Chromic nitrate was stirred under 30° C. to dissolve in deionized water to obtain a solution B;

Niobium oxalate was stirred under 60° C. to dissolve in deionized water to obtain a solution C;

3) Ferric nitrate was stirred under 30° C. to dissolve in tartaric acid to obtain a solution E;

4) The solution A, solution B and solution C were mixed with the solution E to obtain an impregnating solution, the carrier from step 1) was immersed into the impregnating solution, stirred evenly for ultrasound concussion with an ultrasonic cleaner for 30 minutes, evaporated and stirred with water bath under 80° C. for 30 minutes, dried in the oven under 110° C. for 18 hours and then calcined under 475° C. for 4 hours to obtain a catalyst for synergistic denitration and mercury oxidation with V₂O₅, WO₃, Cr₂O₃, Nb₂O₅ and Fe₂O₃ in the following mass percentage: carrier TiO₂ 86%, active component V₂O₅ 2.5%, active component WO₃ 5%, active component Cr₂O₃ 2.5%, active component Nb₂O₅ 2.5% and co-catalyst Fe₂O₃ 1.5%. The prepared catalyst was grounded and sieved to obtain catalyst particles with particle size of 40-60 mesh.

Test 5

0.2 g catalyst particle prepared in example 5 was put into a catalyst denitration activity evaluation unit and activity evaluation was conducted in a fixed bed reactor with an inner diameter of 8 mm. O₂/N₂, NO/N₂, NH₃/N₂, SO₂/N₂ and N₂ were controlled and mixed via mass flowmeter, deionized water was injected into heating pipeline for vaporization by adjusting volume in a micro-injection pump to realize addition of vapor and obtain simulated flue gas in such composition as 5% O₂, 1000 ppmNO, 1000NH₃, 500 ppmSO₂ and 10% H₂O, with N₂ as balance gas, air speed of 300000 h⁻¹, reaction temperature of 350° C. and NH₃/NO as 1. Gas composition was tested with ULTRMAT 32 gas analyzer manufactured by SIEMENS and the denitration efficiency was 86%.

0.2 g catalyst particle prepared in example 5 was put into a catalyst mercury removal activity evaluation unit and activity evaluation was conducted in a fixed bed reactor with an inner diameter of 8 mm. Hg⁰/N₂, O₂/N₂, HCl/N₂, NO/N₂, NH₃/N₂, SO₂/N₂ and N₂ were controlled and mixed via mass flowmeter, deionized water was injected into heating pipeline for vaporization by adjusting volume in a micro-injection pump to realize addition of vapor and obtain simulated flue gas in such composition as 100 µg/m³Hg⁰, 5% O₂, 10 ppmHCl, 300 ppmNO, 50 ppmNH₃, 500 ppmSO₂ and 10% H₂O, with N₂ as balance gas, air speed of 300000 h⁻¹ and reaction temperature of 350° C. Mercury concentration was tested with EMP-2 portable mercury analyzer manufactured by NIC and the oxygenation rate of zero-valent mercury was 84%.

EXAMPLE 6

1) TiO₂ (nanoscale anatase TiO₂, commercially available, particle size less than 30 nm) was dried under 110° C. for 18 hours and used as a carrier;

2) Ammonium metavanadate and ammonium metatungstate were stirred under 60° C. to dissolve in oxalic acid solution to obtain a solution A with pH value less than 2;

Chromic nitrate was stirred under 30° C. to dissolve in deionized water to obtain a solution B;

Niobium oxalate was stirred under 60° C. to dissolve in deionized water to obtain a solution C;

3) Ferric nitrate was stirred under 50° C. to dissolve in deionized water to obtain a solution E;

4) The solution A, solution B and solution C were mixed with the solution E to obtain an impregnating solution, the carrier from step 1) was immersed into the impregnating solution, stirred evenly for ultrasound concussion with ultrasonic cleaner for 30 minutes, evaporated and stirred with water bath under 80° C. for 30 minutes, dried in the oven under 110° C. for 18 hours and then calcined under 475° C. for 4 hours to obtain a catalyst for synergistic denitration and mercury oxidation with V₂O₅, WO₃, Cr₂O₃, Nb₂O₅ and Fe₂O₃ in the following mass percentage: carrier TiO₂ 79.5%, active component V₂O₅ 2.5%, active component WO₃ 5%, active component Cr₂O₃ 5%, active component Nb₂O₅ 5% and co-catalyst Fe₂O₃ 3%. The prepared catalyst was grounded and sieved to obtain catalyst particles with particle size of 40-60 mesh.

Test 6

0.2 g catalyst particle prepared in example 6 was put into a catalyst denitration activity evaluation unit and activity evaluation was conducted in a fixed bed reactor with inner diameter of 8 mm. O₂/N₂, NO/N₂, NH₃/N₂, SO₂/N₂ and N₂ were controlled and mixed via mass flowmeter, deionized water was injected into heating pipeline for vaporization by adjusting volume in a micro-injection pump to realize addition of vapor and obtain simulated flue gas in such composition as 5% O₂, 1000 ppmNO, 1000 NH₃, 500 ppmSO₂ and 10% H₂O, with N₂ as balance gas, air speed of 300000 h⁻¹, reaction temperature of 350° C. and NH₃/NO as 1. Gas composition was tested with ULTRMAT 32 gas analyzer manufactured by SIEMENS and the denitration efficiency was 88%.

0.2 g catalyst particle prepared in example 6 was put into a catalyst mercury removal activity evaluation unit and activity evaluation was conducted in a fixed bed reactor with inner diameter of 8 mm. Hg⁰/N₂, O₂/N₂, HCl/N₂, NO/N₂, NH₃/N₂, SO₂/N₂ and N₂ were controlled and mixed via mass flowmeter, deionized water was injected into a heating pipeline for vaporization by adjusting volume in a micro-injection pump to realize addition of vapor and obtain simulated flue gas in such composition as 100 µg/m³Hg⁰, 5% O₂, 10 ppmHCl, 300 ppmNO, 50 ppmNH₃, 500 ppmSO₂ and 10% H₂O, with N₂ as balance gas, air speed of 300000 h⁻¹ and reaction temperature of 350° C. Mercury concentration was tested with EMP-2 portable mercury analyzer manufactured by NIC and the oxygenation rate of zero-valent mercury was 87%.

EXAMPLE 7

1) TiO₂ (nanoscale anatase TiO₂, commercially available, particle size less than 30 nm) was dried under 120° C. for 24 hours and used as a carrier;

2) Ammonium metavanadate and ammonium metatungstate were stirred under 70° C. to dissolve in oxalic acid solution to obtain a solution A with pH value less than 2;

Chromic nitrate was stirred under 50° C. to dissolve in deionized water to obtain a solution B;

Niobium oxalate was stirred under 70° C. to dissolve in deionized water to obtain a solution C;

3) Ammonium molybdate was stirred under 10° C. to dissolve in deionized water to obtain a solution F;

4) The solution A, solution B and solution C were mixed with the solution F to obtain an impregnating solution, the carrier from step 1) was immersed into the impregnating solution, stirred evenly for ultrasound concussion with ultrasonic cleaner for 60 minutes, evaporated and stirred with

water bath under 90° C. for 60 minutes, dried in the oven under 120° C. for 24 hours and then calcined under 550° C. for 3 hours to obtain a catalyst for synergistic denitration and mercury oxidation with V₂O₅, WO₃, Cr₂O₃, Nb₂O₅ and MoO₃ in the following mass percentage: carrier TiO₂ 84.7%, active component V₂O₅ 5%, active component WO₃ 10%, active component Cr₂O₃ 0.1%, active component Nb₂O₅ 0.1% and co-catalyst MoO₃ 0.1%. The prepared catalyst was grounded and sieved to obtain catalyst particles with particle size of 40-60 mesh.

Test 7

0.2 g catalyst particle prepared in example 7 was put into a catalyst denitration activity evaluation unit and activity evaluation was conducted in a fixed bed reactor with inner diameter of 8 mm. O₂/N₂, NO/N₂, NH₃/N₂, SO₂/N₂ and N₂ via mass flowmeter were controlled and mixed, deionized water was injected into heating pipeline for vaporization by adjusting volume in a micro-injection pump to realize addition of vapor and obtain simulated flue gas in such composition as 5% O₂, 1000 ppmNO, 1000NH₃, 500 ppmSO₂ and 10% H₂O, with N₂ as balance gas, air speed of 300000 h⁻¹, reaction temperature of 350° C. and NH₃/NO as 1. Gas composition was tested with ULTRMAT 32 gas analyzer manufactured by SIEMENS and the denitration efficiency was 90%.

0.2 g catalyst particle prepared in example 7 was into a catalyst mercury removal activity evaluation unit and activity evaluation was conducted in a fixed bed reactor with inner diameter of 8 mm. Hg⁰/N₂, O₂/N₂, HCl/N₂, NO/N₂, NH₃/N₂, SO₂/N₂ and N₂ were controlled and mixed via mass flowmeter, deionized water was injected into heating pipeline for vaporization by adjusting volume in a micro-injection pump to realize addition of vapor and obtain simulated flue gas in such composition as 100 µg/m³Hg⁰, 5% O₂, 10 ppmHCl, 300 ppmNO, 50 ppmNH₃, 500 ppmSO₂ and 10% H₂O, with N₂ as balance gas, air speed of 300000 h⁻¹ and reaction temperature of 350° C.

Mercury concentration was tested with EMP-2 portable mercury analyzer manufactured by NIC and the oxygenation rate of zero-valent mercury was 89%.

EXAMPLE 8

1) TiO₂ (nanoscale anatase TiO₂, commercially available, particle size less than 30 nm) was dried under 120° C. for 24 hours and used as a carrier;

2) Ammonium metavanadate and ammonium metatungstate were stirred under 70° C. to dissolve in tartaric acid solution to obtain a solution A with pH value less than 2;

Chromic nitrate was stirred under 50° C. to dissolve in deionized water to obtain a solution B;

Niobium oxalate was stirred under 70° C. to dissolve in deionized water to obtain a solution C;

3) Ammonium molybdate was stirred under 30° C. to dissolve in tartaric acid to obtain a solution F;

4) The solution A, solution B and solution C with the solution F were mixed to obtain an impregnating solution, the carrier from step 1) was immersed into the impregnating solution, stirred evenly for ultrasound concussion with ultrasonic cleaner for 60 minutes, evaporated and stirred with water bath under 90° C. for 60 minutes, dried in the oven under 120° C. for 24 hours and then calcined under 550° C. for 3 hours to obtain a catalyst for synergistic denitration and mercury oxidation with V₂O₅, WO₃, Cr₂O₃, Nb₂O₅ and MoO₃ in the following mass percentage: carrier TiO₂ 78.5%, active component V₂O₅ 5%, active component WO₃ 10%, active component Cr₂O₃ 2.5%, active component Nb₂O₅

2.5% and co-catalyst MoO₃ 1.5%. The prepared catalyst was grounded and sieved to obtain catalyst particles with particle size of 40-60 mesh.

Test 8

0.2 g catalyst particle prepared in example 8 was put into a catalyst denitration activity evaluation unit and activity evaluation was conducted in a fixed bed reactor with an inner diameter of 8 mm. O₂/N₂, NO/N₂, NH₃/N₂, SO₂/N₂ and N₂ were controlled and mixed via mass flowmeter, deionized water was injected into heating pipeline for vaporization by adjusting volume in a micro-injection pump to realize addition of vapor and obtain simulated flue gas in such composition as 5% O₂, 1000 ppmNO, 1000NH₃, 500 ppmSO₂ and 10% H₂O, with N₂ as balance gas, air speed of 300000 h⁻¹, reaction temperature of 350° C. and NH₃/NO as 1. Gas composition was tested with ULTRMAT 32 gas analyzer manufactured by SIEMENS and the denitration efficiency was 94%.

0.2 g catalyst particle prepared in example 8 was put into a catalyst mercury removal activity evaluation unit and activity evaluation was conducted in a fixed bed reactor with inner diameter of 8 mm. Hg⁰/N₂, O₂/N₂, HCl/N₂, NO/N₂, NH₃/N₂, SO₂/N₂ and N₂ via mass flowmeter were controlled and mixed, deionized water was injected into a heating pipeline for vaporization by adjusting volume in a micro-injection pump to realize addition of vapor and obtain simulated flue gas in such composition as 100 µg/m³Hg⁰, 5% O₂, 10 ppmHCl, 300 ppmNO, 50 ppmNH₃, 500 ppmSO₂ and 10% H₂O, with N₂ as balance gas, air speed of 300000 h⁻¹ and reaction temperature of 350° C. Mercury concentration was tested with EMP-2 portable mercury analyzer manufactured by NIC and the oxygenation rate of zero-valent mercury was 91%.

EXAMPLE 9

1) TiO₂ (nanoscale anatase TiO₂, commercially available, particle size less than 30 nm) was dried under 120° C. for 24 hours and used as a carrier;

2) Ammonium metavanadate and ammonium metatungstate were dried under 70° C. to dissolve in oxalic acid solution to obtain a solution A with pH value less than 2;

Chromic nitrate was stirred under 50° C. to dissolve in deionized water to obtain a solution B;

Niobium oxalate was stirred under 70° C. to dissolve in deionized water to obtain a solution C;

3) Ammonium molybdate was stirred under 50° C. to dissolve in deionized water to obtain a solution F;

4) The solution A, solution B and solution C were mixed with the solution F to obtain an impregnating solution, the carrier from step 1) was immersed into the impregnating solution, stirred evenly for ultrasound concussion with ultrasonic cleaner for 60 minutes, evaporated and stirred with water bath under 90° C. for 60 minutes, dried in the oven under 120° C. for 24 hours and then calcined under 550° C. for 3 hours to obtain a catalyst for synergistic denitration and mercury oxidation with V₂O₅, WO₃, Cr₂O₃, Nb₂O₅ and MoO₃ in the following mass percentage: carrier TiO₂ 72%, active component V₂O₅ 5%, active component WO₃ 10%, active component Cr₂O₃ 5%, active component Nb₂O₅ 5% and co-catalyst MoO₃ 3%. The prepared catalyst was grounded and sieved to obtain catalyst particles with particle size of 40-60 mesh.

Test 9

0.2 g catalyst particle prepared in example 9 was put into a catalyst denitration activity evaluation unit and activity evaluation was conducted in a fixed bed reactor with inner

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diameter of 8 mm. O_2/N_2 , NO/N_2 , NH_3/N_2 , SO_2/N_2 and N_2 via mass flowmeter were controlled and mixed, deionized water was injected into heating pipeline for vaporization by adjusting volume in a micro-injection pump to realize addition of vapor and obtain simulated flue gas in such composition as 5% O_2 , 1000 ppmNO, 1000ppm NH_3 , 500 ppm SO_2 and 10% H_2O , with N_2 as balance gas, air speed of 300000 h^{-1} , reaction temperature of 350° C. and NH_3/NO as 1. Gas composition was tested with ULTRMAT 32 gas analyzer manufactured by SIEMENS and the denitration efficiency was 96%.

0.2 g catalyst particle prepared in example 9 was put into a catalyst mercury removal activity evaluation unit and activity evaluation was conducted in a fixed bed reactor with an inner diameter of 8 mm. Hg^0/N_2 , O_2/N_2 , HCl/N_2 , NO/N_2 , NH_3/N_2 , SO_2/N_2 and N_2 were controlled and mixed via mass flowmeter, deionized water was injected into heating pipeline for vaporization by adjusting volume in a micro-injection pump to realize addition of vapor and obtain simulated flue gas in such composition as 100 $\mu g/m^3 Hg^0$, 5% O_2 , 10 ppmHCl, 300 ppmNO, 50 ppm NH_3 , 500 ppm SO_2 and 10% H_2O , with N_2 as balance gas, air speed of 300000 h^{-1} and reaction temperature of 350° C. Mercury concentration was tested with EMP-2 portable mercury analyzer manufactured by NIC and the oxygenation rate of zero-valent mercury was 95%.

The aforesaid example is just a better scheme for the present invention, instead of any form of limitation, and other variants and versions are allowed on the premise of not exceeding the technical solution recorded in the claims.

The invention claimed is:

1. A method for preparing a catalyst for synergistic control of oxynitride and mercury, wherein the method comprises the following steps:

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- 1) drying TiO_2 and use TiO_2 as a carrier;
- 2) stirring ammonium metavanadate and ammonium metatungstate under 50° C.-70° C. to dissolve in an oxalic acid or tartaric acid solution to obtain a solution A with pH value less than 2; stirring chromic nitrate under 10-50° C. to dissolve in deionized water or tartaric acid to obtain a solution B; stirring niobium oxalate under 50-70° C. to dissolve in deionized water or tartaric acid to obtain a solution C;
- 3) stirring cupric nitrate under 10-50° C. to dissolve in deionized water or tartaric acid to obtain a solution D; or stirring ferric nitrate under 10-50° C. to dissolve in deionized water or tartaric acid to obtain a solution E; or stirring ammonium molybdate under 10-50° C. to dissolve in deionized water or tartaric acid to obtain a solution F;
- 4) mixing the solution A, solution B and solution C with one of the solution D, solution E and solution F to obtain an impregnating solution, immersing the carrier from step 1) into the impregnating solution, stirring evenly for ultrasound concussion, evaporating and stirring with water bath for 10-60 minutes, drying in the oven and then calcine under 400° C.-550° C. for 3-5 hours to obtain the catalyst for synergistic control of oxynitride and mercury.
2. The preparation method according to claim 1, wherein the drying in step 1) is drying under 105° C.-120° C. for 12 hours-24 hours.
3. The preparation method according to claim 1, wherein the ultrasound concussion time in step 4) is 10-60 minutes.
4. The preparation method according to claim 1, wherein the water bath temperature in step 4) is 70-90° C.
5. The preparation method according to claim 4, wherein the drying condition in oven in step 4) is drying under 105-120° C. for 12-24 hours.

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